The Journal of HEREDITY

A NEW TROPICAL HYBRID GRAPE
(See Page 193)

The Physician and Medical Genetics
Eugenics and the National Defense
Propagation of the Sugar Beet
Recessive Achondroplasia in Cattle
Finding and Conserving the Gifted
Antigen-Difference in Dove Species

VOLUME 32 JUNE, 1941 NUMBER 6

The American Genetic Association

An incorporated organization devoted to promoting a knowledge of the laws of heredity and their application to the improvement of plants, animals, and human racial stocks

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The JOURNAL OF HEREDITY is published monthly by the AMERICAN GENETIC ASSOCIATION at 32nd Street and Elm Avenue, Baltimore, Md., and Victor Building, Washington, D. C. Address all communications regarding editorial matters to Room 308, Victor Building, Washington, D. C. Communications regarding the business management of The JOURNAL OF HEREDITY may be addressed to the publication office, 32nd Street and Elm Avenue, Baltimore, Md., or to the Victor Building, Washington, D. C. Entered as second-class matter February 24, 1923, at the postoffice at Baltimore, Maryland. Acceptance for mailing at the special rate of postage provided for in section 1103, Act of October 3, 1917, authorized December 20, 1918.

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The

Journal of Heredity

Vol. XXXII **JUNE, 1941** **No. 6**

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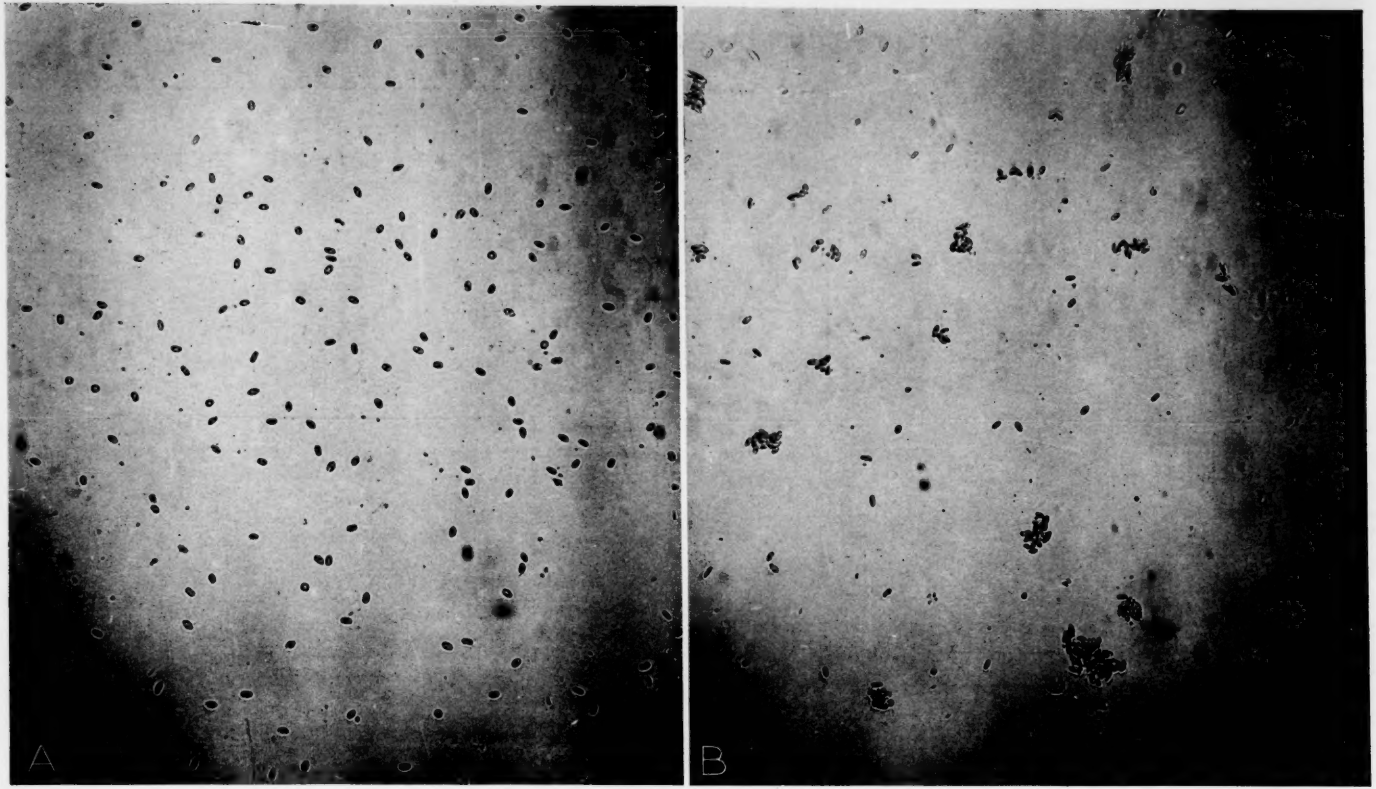


AGGLUTINATION OF BLOOD CELLS OF RINGNECK AND PEARLNECK DOVES

Frontispiece

A — Red blood cells of Ring dove: The elliptical shape is typical of most bird corpuscles. In this photomicrograph the cells are distributed at random, as would be expected if they were in a suspension of saline. Actually, this picture was taken of Ring dove cells mixed with Pearlneck antiserum, which had previously been absorbed with Ring dove cells. The absence of clumping of these cells shows that the absorption of Ring dove antibodies in the Pearlneck antiserum was complete at the dilution used, for the different antigens and their respective antibodies are entirely specific in their reactions.

B — Agglutination of red blood cells of Pearlneck by anti-Pearlneck serum which had previously been absorbed by Ring dove cells. Note that most of the corpuscles are collected in several clumps, but that a few single cells are scattered over the field. This illustrates agglutination as it occurred at practically the last dilution of antiserum at which clumping of the cells was visible. In complete agglutination, all the cells of the antiserum-cell mixture would be in a single clump. According to our hypothetical explanation in the text, the clumping of these cells is by virtue of the union of the "small circle" antigen with its particular antibody (See Figure 2).

PICTORIAL REPRESENTATION OF THE ANTIGENIC DIFFERENCES BETWEEN TWO DOVE SPECIES*

R. W. CUMLEY AND M. R. IRWIN
University of Wisconsin

LANDSTEINER and co-workers[4,5] first showed that a definite distinction between the red blood cells of two species could be made by immunological methods. Reports[1,2] from this laboratory have confirmed these findings, and have further shown[3] that the antigenic properties, by which the cells of one species differ from those of the other, are heritable. Although the reactions by which the differentiation is effected are clearly visible to the eye, the processes involved are somewhat complex to one not acquainted with the various steps.

Hypothetically, one of the most simple relationships possible between any two species would be that wherein the cells of each species possessed but two antigens: One antigen in each species would be *shared* with the other species, and one antigen in each species would be *specific* for that species. Thus the first species would contain antigens *A* and *B*, the second species would contain *B* and *C*. Antigen *B* would be *common* to both, and *A* and *C*, respectively, would differentiate the two species. If the fundamental procedures necessary to establish such relationships between species are grasped, no one will have serious difficulty in understanding the more complex relationships. The necessary steps in the elucidation of these relationships are given below, and they are presented pictorially in Figure 2. For this purpose, a comparison will be made between the cells of a Pearlneck (*Streptopelia chinensis*) and a Ring dove (*S. risoria*). See Figure 1.

Explanation of Chart

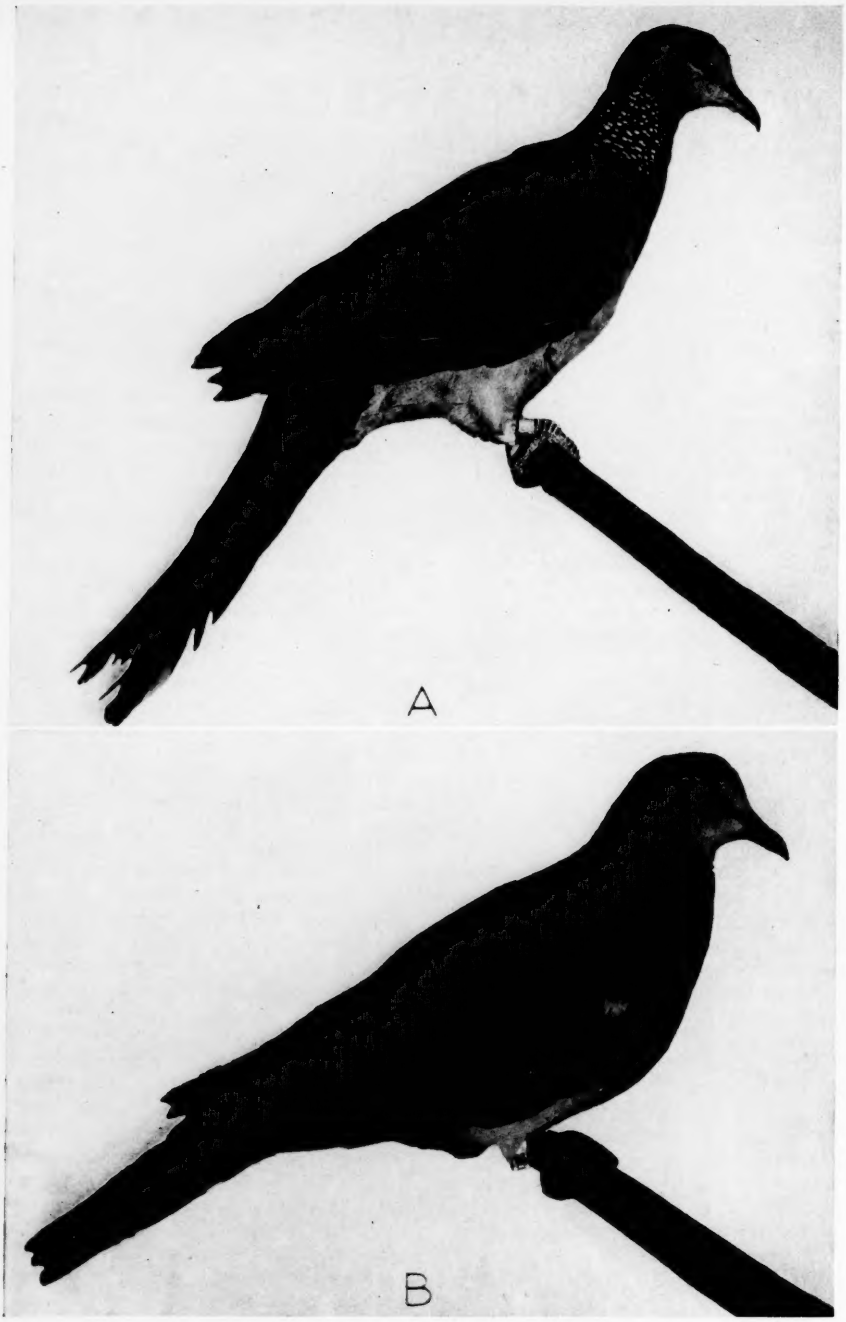
Figure 2. (1) The antigens in the erythrocytes of Pearlneck are represented symbolically as being of two kinds, viz., one in the shape of a triangle, the other in that of a small circle. One of the basic tenets of immunology is that of the specificity of the antibodies for the different constituents of an antigenic complex. That is, distinct antibodies should be produced against each of these hypothetical antigens of Pearlneck when its cells are injected into another species, as the rabbit. The antibody against the "triangle" antigen will react only with (cause agglutination of) cells containing this "triangle" antigen, and the antibody for the "small circle" antigen will interact only with cells containing the particular antigen. The interaction of a specific antibody only with its particular antigen (or with a similar chemical substance) has been explained in various ways, but for our purpose it may be visualized as being analogous to a "lock and key" relationship.

The Pearlneck doves are bled from a wing vein into tubes containing an anticoagulating solution. The cells are separated from the serum by centrifugation, and are then washed several times in physiological saline (isotonic for bird cells, 0.75% Na Cl).

(2) Antibodies are engendered in the rabbit by immunization with Pearlneck cells. Pursuing our original assumption, the antibodies should be of two kinds, one kind capable of uniting only with the "triangle" antigen, the other only with the "small circle" antigen. The two kinds of antibodies are portrayed as fitting the "receptors" provided by the cells, an explanation that has long been used for the observed specificity of antigens and antibodies.

(3) The immune serum is collected from the immunized rabbit, usually after

*Paper No. 279 from the Department of Genetics, Agricultural Experiment Station, University of Wisconsin.

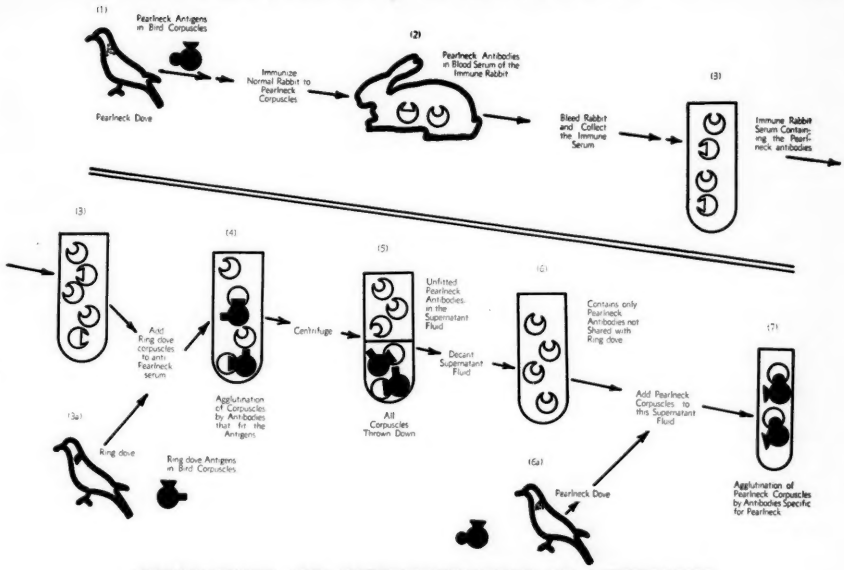


PEARLNECK AND RINGNECK DOVES

Figure 1

A — Pearlneck dove (*Streptopelia chinensis*). This is an Asiatic species, which ranges through India, South China, French Indo-China, Malay Peninsula, Borneo, and nearby islands.

(*Continued on page* 181)


(1)
Pearlneck Antigens in Bird Corpuscles
Pearlneck Dove
Immunize Normal Rabbit to Pearlneck Corpuscles
(2)
Pearlneck Antibodies in Blood Serum of the Immune Rabbit
Bleed Rabbit and Collect the Immune Serum
(3)
Immune Rabbit Serum Containing the Pearlneck antibodies
(3)
(4)
(5)
(6)
(7)
Add Ring dove corpuscles to anti-Pearlneck serum
Centrifuge
Unfitted Pearlneck Antibodies in the Supernatant Fluid
Decant Supernatant Fluid
Contains only Pearlneck Antibodies not Shared with Ring dove
Add Pearlneck Corpuscles to this Supernatant Fluid
Agglutination of Corpuscles by Antibodies that fit the Antigens
All Corpuscles Thrown Down
Agglutination of Pearlneck Corpuscles by Antibodies Specific for Pearlneck
(3a)
Ring dove
Ring dove Antigens in Bird Corpuscles
(6a)
Pearlneck Dove

PRODUCTION AND DIFFERENTIATION OF ANTIBODIES

Figure 2

This chart shows the procedure necessary to demonstrate that the Pearlneck dove and the Ringneck dove have at least three antigens, one in common in the two species (the "triangle" antigen), and two different (the "small circle" and the "bar" antigens). For details see text beginning on page 179.

3 to 4 weeks of injections. If 0.1 cc. of this immune serum in successive dilutions (in saline) is mixed in small tubes with one drop of 2.5% suspension of either Pearlneck or Ring dove cells, it will be found that both kinds of cells will probably be agglutinated at the same end-dilution of antiserum. (The dilutions in the routine tests usually range in halved concentrations of antiserum, beginning with one part of serum to 90 parts of saline, 1 part in 180, 1 part in 360 . . . 1 part in 30,720 or more.) The agglutination of Ring dove cells by a Pearlneck antiserum, then, is by virtue of the antigen that is common to both dove species. But by these tests alone, no differentiation of the cells of the two species is possible.

(4) According to our hypothetical case, Pearlneck and Ring dove cells share one antigen (the "triangle"). Therefore, if sufficient Ring dove cells are added to the anti-Pearlneck serum, all the antibodies *specific* to the *common* antigen will be absorbed on the surface of the Ring dove cells. This will cause the cells to be agglutinated, and these antibodies are thereby removed from the antiserum. This is represented in step 4 of Figure 2, in which is seen the union of the "triangle" antibody with its antigen. If sufficient Ring dove cells are added to the antiserum so as to provide for the union of cells with all the antibodies for the *common* antigen ("triangle") of

Legend to Figure 1 — *Continued*

It is much wilder than the Ring dove, and has not attained the degree of domestication of the latter. Within recent years the Pearlneck dove has been introduced into Southern California, and appears to thrive there. Note the "pearly" markings on the neck. *B* — Ring dove (*Streptopelia risoria*). This is a domesticated dove. It is a blond with dark eyes, and is probably a mutant form of the wild species, *St. decaocto*. A recessive type is pure white with dark eyes, and is highly regarded, even said to be an object of worship, in India. Note the "ring" on the neck.

the cells of the two species, it is possible to remove from the serum all such antibodies. But the antibodies which fit the "small circle" antigens are not affected by this absorption. (In addition to the "triangle" antigenic character, Ring dove cells are portrayed as having a "bar" antigen, but this has no counterpart in the Pearlneck antiserum, and does not enter into the agglutination or absorption.)

(5) and (6) The Ring dove corpuscles with their attached antibodies ("triangle") are packed in the bottom of the tube by centrifugation, and the supernatant fluid pipetted off. Within this fluid now are found only the antibodies for the "small circle" antigens of Pearlneck cells. (This can be tested by mixing two or three drops of it with one drop of Ring dove cells, allowing it to stand for 1-2 hours, and observing the cells under the microscope. If the cells are distributed at random, the absorption was complete, i.e., all antibodies for Ring dove cells were removed during the absorption.) See Frontispiece *A*.

(7) This absorbed antiserum ("reagent" or "test fluid") will agglutinate Pearlneck cells, but not those of Ring dove, by virtue of the interaction of the "small circle" antigen and antibody. Frontispiece *B* is a photomicrograph of agglutination of Pearlneck cells as it occurs in a high dilution of this reagent.

Specific and Common Antigens

Thus, in comparison of the cells of Pearlneck and Ring dove by this method, the kinds of antigens in the Pearlneck are recognized in two ways. First, the agglutination of the cells of both species by anti-Pearlneck serum is by virtue of the antigen that is found in each, i.e., the *common* antigen. Second, the antibody specific to the *common* antigen may be removed from the serum by absorption with an excess of Ring dove cells, leaving a reagent whose antibody will interact only with its specific antigen in Pearlneck cells.

Thus it would be possible to assay the *common* and *specific* antigens of Ring dove cells by reciprocal tests. The antiserum to Ring dove would agglutinate both Ring dove and Pearlneck cells, and the reaction with Pearlneck cells would be by virtue of the antigen *common* to these species; i.e., the "triangle" antigen. When mixed with an excess of Pearlneck cells, the antibody for this *common* antigen would be adsorbed on the cells, leaving a reagent containing only the antibody for the antigen *specific* to Ring dove cells; i.e., the "bar" antigen. Such a reagent would agglutinate only Ring dove cells, by virtue of the combination of the "bar" antigen and its particular antibody.

One must keep in mind, especially, that within an antiserum, each antibody reacts with its own specific antigen* and with no other. The principles set forth above would hold if there were more than one antigen *peculiar* to both Pearlneck and Ring dove, and two or more *common* to both species.

In succeeding articles, we shall give a diagrammatic scheme of the relationship of the antigens of the species hybrid to those of the parents, and of the separation in the backcross individuals of the antigens specific to one of the parental species.

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*Actually, the work of investigators in immunochemistry has shown that an antibody, to an antigen whose chemical nature is known, may react with antigens of a similar but not identical structure.

ACHONDROPLASIA IN CALVES*

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ACHONDROPLASIA in calves has been reported by several writers, most of them in Europe. The term "bull-dog" has been applied to calves that show achondroplasia of which we are reporting two cases.

Seligmann[9] in 1904 reported that as high as twenty-five per cent of the calves in Dexter herds were born with short round heads, depressed nostrils and projecting lower mandibles combined with extreme shortness of the limbs. The vertebral column was short as was the trunk. The animals had a long and fleshy tongue and short stout neck with poorly developed chest. The thymus was normal. The cows lost water during pregnancy and often aborted at the sixth, seventh or eighth month. The conclusion was that the condition was due to cretinism associated with placental disease.

Wilson[11] in 1909 in a study of the formation of the Dexter breed of cattle stated that when Dexters were mated together, from twenty-five to fifty per cent of the calves were useless. The Dexter breed is thought to have originated from crossing the two breeds of cattle, Irish Kerry and Red Devon.

Crew[2] in 1923 presented evidence that the "bull-dog" condition in Dexter calves is inherited. The Dexter breed is composed of animals which have been selected for the characters of small size, short legs and short broad heads. He further described the condition in that the upper lip is split and the swollen tongue is thrust out and over the nose. The tail is situated high on the back, and umbilical hernia is often present. The skin hangs loosely in folds, and there is much subcutaneous fat. The limbs are extremely short and the digits are separated wider than usual. In general, the abnormalities are constant and similar to those of achondroplasia in man. Crew suggested that the condition resulted from a malfunctioning of the pituitary between the second and third months of intra-uterine life.

Heizer and Hervey[5] in 1937 reviewed the hypothesis advanced by Crew to explain the inheritance of this abnormality, which has not been fully supported by the evidence.

Carmichael[1] reports the occurrence of twelve typical "bull-dog" calves in a herd of Nganda cattle in Uganda. It is of interest to note that like the Dexters, the Nganda cattle originated from the crossing of two breeds of cattle in Africa.

Hutt[6] in 1934 stated that from the evidence of Seligmann and Crew, it appeared that the correct Dexter type was produced by the presence in the heterozygous state of a partially dominant gene which causes the short legs and brachycephaly considered good type in that breed. When these genes are in the homozygous state, a "bull-dog" calf results. Animals which lack the gene entirely are of the Kerry type. When Dexters are crossed with the longer legged Kerry (one of the breeds from which they originated), no "bull-dog" calves are produced. Hutt calls this condition "dominant" achondroplasia in contrast to "recessive" achondroplasia, to be described in the rest of this paper.

Wriedt and Mohr, according to Mohr,[7] discovered a similar but less extreme condition in the Telemark cattle of Norway. These calves were carried full term but, with the exception of one which survived for three months, they were unable to stand and died within a few days after birth from asphyxiation due to mechanical ob-

*The author wishes to thank Dr. H. M. Mauger and Mr. V. G. Foust of the Department of Veterinary Anatomy for performing the dissection; also Professor L. K. Bear of the Department of Animal Husbandry for the photograph used in this paper.

struction of the respiratory tract. There was evidence to show that the pituitary was abnormal, and the calf which lived for three months was given pituitary preparations. The calves had short heads and short upper jaw-bones. The legs were stumpy, crooked and could not support the animal's weight. Telemark cattle are normal and not short-legged or brachycephalic as are the Dexter cattle. This type of achondroplasia was proven to be recessive in its inheritance.

Punnett[8] reports the experiments of T. H. Riches where a Telemark bull was mated to Dexter females. The results showed that the two types of achondroplasia were due to entirely independent genes.

Eaton[4] states that recessive achondroplasia has also been reported in Holstein cattle in Germany.

Downs[3] in 1928 reported the occurrence of a "Dexter Monster" from a Jersey-Holstein crossbred cow mated to a Holstein bull. This cow had previously dropped a "bull-dog" calf by an unknown sire. On examination there was no hard palate present, the hypophysis was not found, there was only one parathyroid, and the thyroid was small while the thymus gland was large but microscopic examination revealed the picture of a normal active thymus. The conclusion was that heredity and the endocrine system are both concerned in this condition.

Winters[12] has made no specific report on "bull-dog" calves but indicates that he has seen them in the Guernsey breed.

Description of Cases

Case I

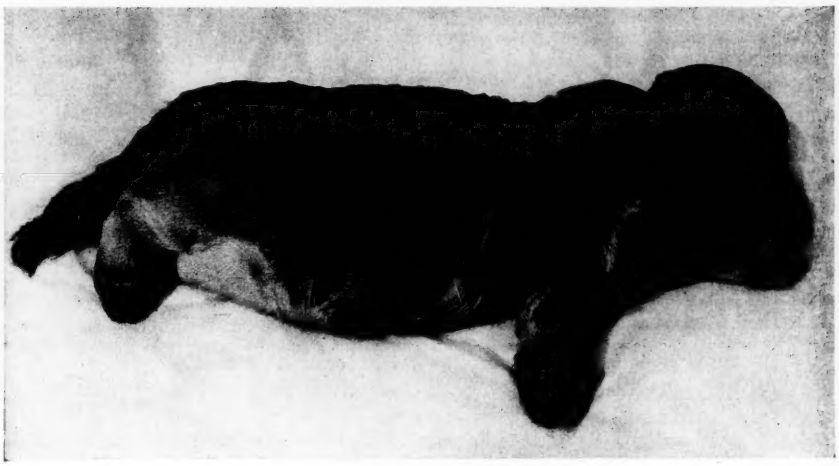
In September of 1938, we observed a "bull-dog" female calf which had been mounted. This animal had been born that summer and was dead when discovered by the owner in the field. It showed the color markings of a Guernsey and was from grade Guernsey parents, who, according to the owner, were normal. The calf as mounted was ten inches high and twenty-seven inches long. The legs were about four inches in length. The other features were similar to Case II which will be described in more detail.

Case II

This animal, a grade Jersey male shown in Figure 3, was brought to the Department in August of 1939 by a farmer on whose farm it had been born. It was born alive and lived about an hour. The cranium was bulging, the nose depressed and the lower jaw protruded. The neck was very short and the head seemed to be almost attached to the body. The legs were four inches long and they were out of position in that the normal anterior side was lateral in position. As the animal was mounted for classroom purposes, the skull and legs were not dissected. However, the thoracic and abdominal regions were dissected. Among the findings were that the vertebral column dropped noticeably dorsal to the heart. The heart was rotated out of normal position with its long axis resting in a transverse plane while the left auricle and ventricle were in contact with the lower thoracic wall and the floor of the thoracic cavity respectively. There was a distortion of all viscera as far as position was concerned. The thymus gland was enlarged. There was a right scrotal hernia which made the scrotum appear large on gross examination. Fourteen pairs of ribs were present but this is not an uncommon occurrence in normal cattle.[10] A dense fibrous cord about one fourth of an inch in diameter and four inches in length was attached firmly to the ventral abdominal wall four inches behind the umbilicus. The unattached end was free but appeared to have been severed from some previously attached point, in all probability the skin.

Discussion

A visit to the owner and inspection of the mother revealed that she was a normal grade Jersey cow, while the sire was also a normal grade Jersey. Pedigrees of the parents are not available to determine if there was any close breeding. This was the fifth calf



RECESSIVE ACHONDROPLASIA
Figure 3

Grade Jersey Male Calf showing achondroplasia, the result of homozygous recessive genes.

dropped by this cow, and of the four preceding calves three were normal and one was said by the owner to have been a "bull-dog." It was sired by a grade Guernsey bull. In 1940, this cow again gave birth to a normal heifer calf. The cow's progeny are listed in Table 1.

From the anatomical features of the two animals and the other information available, it is concluded that these are cases of recessive achondroplasia.

Recently it has been reported to us that a breeder of purebred Ayrshires in Ohio had a "bull-dog" calf born into his herd. This calf was produced from the mating of a female back to her own sire.

While most of the cases of "bull-dog" calves have been reported in Europe, there is no question but that the recessive type genes for this character are present in some of our breeds of cattle at the present time, especially dairy cattle. Probably more of these calves are born in this country than any one suspects because they are not talked about, as many breeders are ignorant of the hereditary principles which govern such characters as these. Breeders often hold the opinion that deviations from color, monsters, etc., indicate that the animals are not purebreds so if such animals are born in a herd, they are generally destroyed or sold out of the herd as soon as possible. Instead of using the principles of heredity to help eliminate the genes from their herds, they forget about the animals which show the characters and continue breeding animals which carry the genes, hoping that chance will be with them and that they will have no more undesirable animals produced.

Table 1

Year	Sex	Breed of Sire
1935	Male	Gr Shorthorn
1936	Female	Gr Shorthorn
1937	Bulldog	Gr. Guernsey
1938	Female	Gr. Guernsey (same as
1939	Male Bulldog	Gr. Jersey above sire)
1940	Female	Gr. Guernsey

Summary

The literature dealing with achondroplasia in cattle has been reviewed and two cases of achondroplasia are reported which are believed to be of the recessive type. Mention is also made

of a "bull-dog" calf from purebred Ayrshire parents.

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The Expanding Literature on Maize

INDIAN corn or maize is America's most important, and the World's second most important, crop plant. In addition it is unique in being one of the most useful plants for research in genetics, cytology and other subjects and in holding the key to various problems in ethnology and anthropology. It is inevitable, therefore, that an enormous literature should grow up on the subject of maize. Yet when this material has been assembled, classified and tabulated in a bibliography covering a period of twenty years,* one suddenly is amazed not only at the magnitude of the literature but also at the fortitude of the bibliographer.

Approximately the first three hundred pages of this volume are devoted to a subject index in which some eleven thousand entries are arranged alphabetically by subject. Each broad, general subject is subdivided into numerous subheadings, a key to which precedes the actual citations. Cross-indexing has been freely utilized. All citations are numbered and these numbers are used for reference in the author index which comprises the last 64 pages.

Readers of this Journal will be especially interested in the section on Maize Genetics which includes approximately twelve hundred entries and covers the literature on breeding, cytology, genetics and other closely related subjects such as xenia, pollination and sterility.

The usefulness of any comprehensive bibliography of this type is directly proportional to the degree with which accuracy and completeness are combined with an intelligent understanding of the subject matter. Judged by this criterion the present volume ranks high and it should prove useful to workers in many different fields. It is to be hoped that additional bibliographies on maize, covering other periods, will be forthcoming from the same source.

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*Maize Bibliography for the years 1917 to 1936, inclusive. Compiled by J. C. Cunningham. Contributions from Iowa Corn Research Institute. Vol. 2: 1-364. Published by Iowa State College, Ames, Iowa.

ASEXUAL PROPAGATION OF SUGAR BEETS

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THE desirability of having clones of beets whenever genotypic uniformity is desired is appreciated by all who are familiar with the extreme degree of heterogeneity which characterizes most sugar beets grown from seed. For physiological studies with sugar beets, plant material of identical genotype can be obtained by the use of cuttings. In genetic studies, the cuttings serve to perpetuate genotypes of special interest and to increase the number of plants from any individual genotype. During the past ten years, vegetative propagation of sugar beets has been used rather extensively at the U. S. Sugar Plant Laboratory, Salt Lake City, Utah. Many clones have been produced, two of which, started in 1932, are still maintained. Interest expressed in the procedure has prompted the present report on the methods used for clonal reproduction.

An early attempt to introduce asexual propagation of sugar beets was made by Nowoczek[2] of Kaaden, Bohemia, in 1891. Nowoczek's method of making the cuttings was to utilize buds forced from leaf axils of the crown of the beet. This method of propagating beets was patented in Germany September 25, 1890, as Patent No. 57245.[2]

Apparently many have used this method in connection with beet breeding. The writer has made cuttings from crown buds of beets (Figure 5) but the rooting was observed to be relatively slow and the number of cuttings that could be made from a single beet was limited. The cuttings made from the succulent growth of semi-vegetative beet seedstalks (Figures 6 and 7) seem to root more rapidly than cuttings from crown buds and the number that can be made from an individual plant is much greater.

The foremost requirement for production of the semi-vegetative seedstalks desirable for cuttings, is an understanding and appreciation of some of the physiological principles[3] involved in the change from vegetative to reproductive development. The semi-vegetative growth represents an intermediate condition between the dense vegetative rosette characterized by extremely short internodes and the fully developed seedstalk with long internodes. The initiation of the seedstalk and the lengthening of the internodes in biennial varieties of beets is induced by prolonged exposure to relatively low temperatures (40° to 50° F.) accompanied or followed by extended exposure to long photoperiods[1] (preferably continuous light). The requirements of temperature and light exposures for initiation of seedstalks depend on the genetic composition of the beets. There is wide variation in this respect among both biennial and annual types. However, the effect of temperature on induction of seedstalks is much more important in biennial beets than in wild or annual beets. Certain of the wild annual species will develop seedstalks without thermal induction providing they receive adequate photo-induction. For this reason it is easy to secure semi-vegetative seedstalks of *Beta maritima* (Figure 7C) by controlling the photoperiods without controlling temperature.

Development of a semi-vegetative type of growth in biennial beets is further complicated by a certain amount of after-effects from both thermal and light exposures. The induction process, like certain chemical reactions, is sometimes difficult to start but develops so much momentum after it gets started that it may proceed further than is desired be-

fore it can be stopped or reversed. Thermal induction in biennial varieties is a slow process and sometimes requires a period of two or three months or longer. After prolonged low temperature exposure, however, especially when accompanied by long photoperiods, the induction process may reach such a momentum that biennial beets may pass almost directly from the vegetative phase into the flower phase of growth with the semi-vegetative transition period being hardly noticeable. For best results in producing a semi-vegetative type of growth, effects of temperature and light treatments should be anticipated in advance and daily observations are sometimes advisable to see that the type of growth does not become too strongly vegetative or too much inclined in the direction of flowering.

The type of growth on the seedstalk can be influenced to some extent by decapitating growing points. Decapitation of growing points destroys the terminal dominance, which is very strong in many types of sugar beets, and encourages the development of new buds and new branches. The advantage of having a branch with many vegetative buds which will produce several cuttings (Figure 6*C*), instead of only one strong dominant bud which will produce only one cutting is important when numerous cuttings are desired.

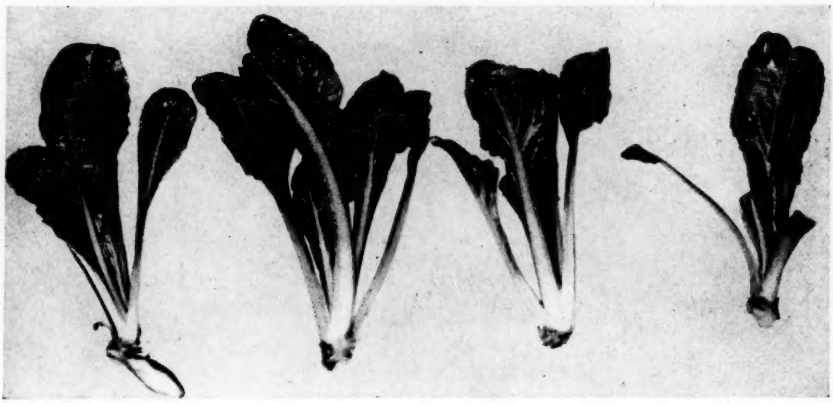
Production of the semi-vegetative condition desired for cuttings depends to some extent upon facilities for controlling temperature and light. Considerable thermal induction frequently takes place in the field in the vicinity of Salt Lake City during the months of September and October but sometimes it has been advisable to allow thermal induction to continue further by storage at temperatures of 40° to 50° F. In the greenhouses at the U. S. Sugar Plant Field Laboratory at Salt Lake City, Utah, two general temperatures are maintained. During the winter months an attempt is made to hold one greenhouse compartment between 50° and 58° F. and another compartment between 60° and 75° F. Within sub-

CROWN BUDS
Figure 4

Beet showing development of crown buds, which can be cut off and rooted, as shown in Figure 5.

compartments at these two temperatures different photoperiods are maintained. Long photoperiods are produced by supplementing the natural period of daylight with light from Mazda lamps (150 to 500-watt capacity).

Continuous light in the greenhouse compartment held at 50° to 58° F. is favorable for initiation of seedstalks or for further photothermal induction at any time when plants become too strongly vegetative in the warm compartment. During short winter days the warm greenhouse compartment with the natural daylight period usually suffices to check the reproductive type of development but when an extreme environment, more favorable for vegetative growth and more unfavorable for photothermal induction, is desired the plants are placed in a subcompartment at the warm temperature where an eight-hour photoperiod is



CUTTINGS FROM CROWN BUDS
Figure 5

Tissue from the crown of an old beet is usually hard and does not strike root as readily as cuttings from semi-vegetative seedstalks.

maintained by the use of black cloth shades.

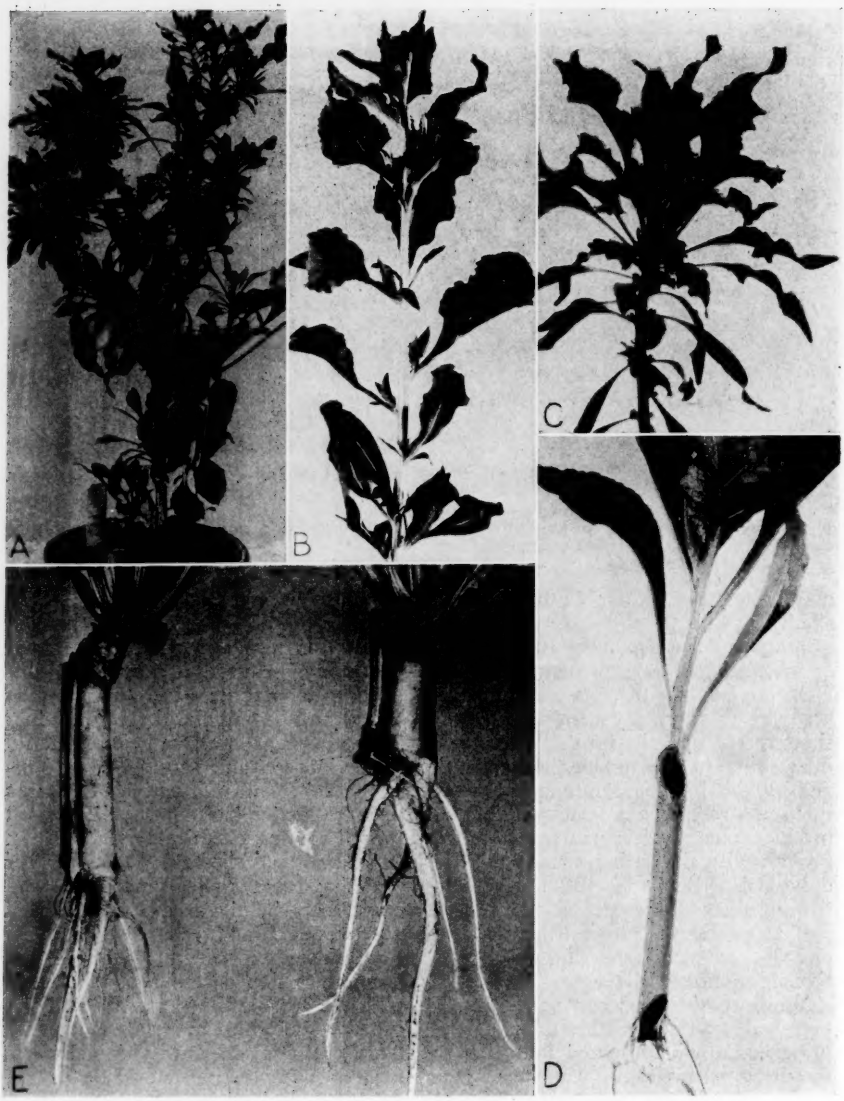
The beets are grown in 10-inch pots or in small nail kegs to permit shifting from one compartment or subcompartment to another. By careful observations to see that the type of growth is developing in the manner anticipated, and by shifting the plants as frequently as desired, it has been possible to produce the semi-vegetative type of growth with the rather crude facilities described. Better facilities for controlling light and temperature would no doubt increase the possibilities for producing the exact degree of semi-vegetative development desired.

While rooting beet cuttings in a cutting bed, further consideration of the principles of photothermal induction of flowering is advisable. Cuttings made from seedstalks strongly inclined in the direction of flowering are likely to be small and seedy and for this reason are usually undesirable. A short photoperiod for the plants while in the cutting bed is usually advisable to keep the cuttings vegetative. Sometimes, however, one may wish to hasten flowering in the new cuttings and any degree of flowering in the newly rooted plants can be brought about by controlling temperatures and photoperiods before and during the time of rooting.

Rooting has been sufficiently rapid with vigorous and succulent beet cuttings from semi-vegetative seedstalks that the writer has not regularly used special rooting chemicals or hormones. In several tests, however, beet cuttings initiated roots faster and developed more roots by the use of *a*-naphthaleneacetic acid and related substances. Preliminary experiments* indicate that a concentration of *a*-naphthaleneacetic acid of 50 p. p. m. (parts per million) in talc and applied to the base of moistened cuttings constitutes a good treatment. Concentrations of 500 p. p. m. produced decided injury.

In the absence of hormone treatment, roots on beet cuttings are always initiated from the cut surface and on the same side of the stem as that on which the leaves are situated (Figures 6*D* and 6*E*). Beet cuttings treated with *a*-

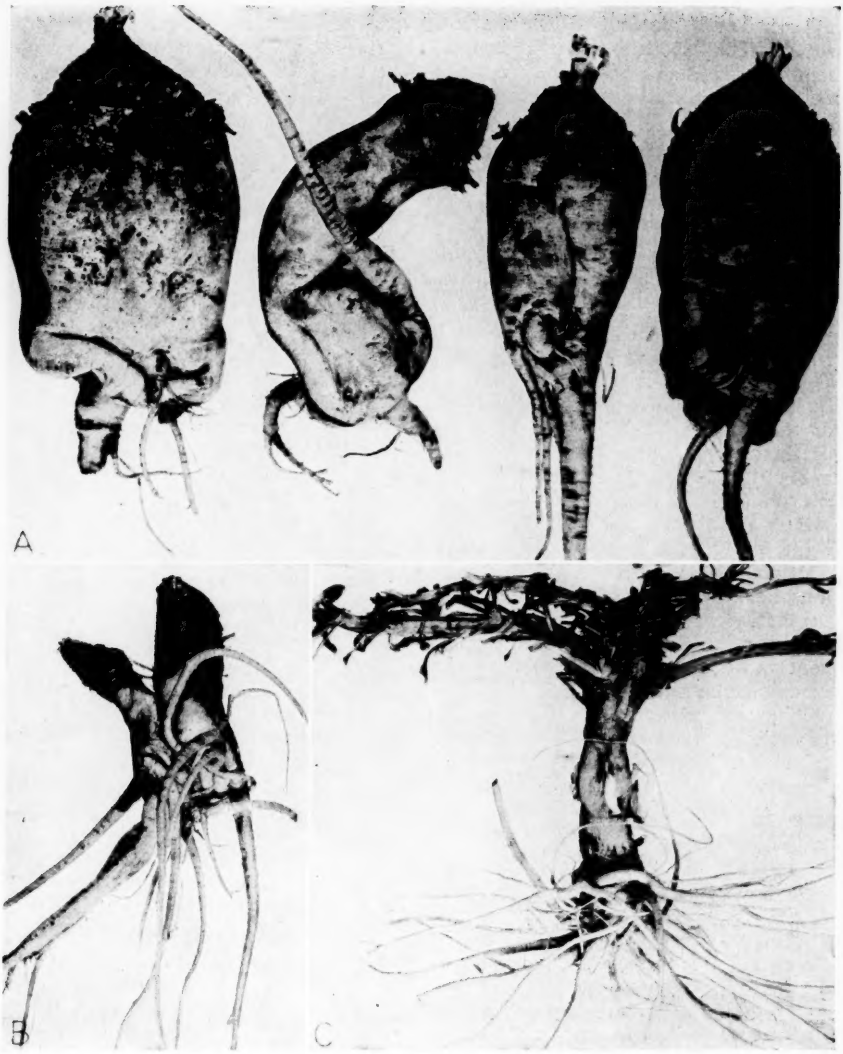
*These experiments were conducted by Myron Stout, Assistant Physiologist, Division of Sugar Plant Investigations, Bureau of Plant Industry, U. S. Department of Agriculture.



PROPAGATION FROM SEMI-VEGETATIVE SEEDSTALKS

Figure 6

A — A semi-vegetative seedstalk. This semi-vegetative growth of the seedstalk was initiated by placing the plant in a cool-long-day environment. After initiation of the seedstalk the plant was transferred to a warm-short-day environment. Under the later environment the photothermal induction process was unable to continue and vegetative growth was gradually resumed. The difference between vegetative growth and semi-vegetative growth is shown in (*B*), a semi-vegetative stalk which will produce about eight cuttings, as compared with (*C*), a vegetative stalk which will produce only one good cutting. *D* — Roots initiated in eleven days without hormone or auxin treatment. *E* — Appearance of cuttings after growth is established showing part of the storage tissue derived from the stem.



TYPICAL GROWTH FROM VEGETATIVE CUTTINGS

Figure 7

A — Typical growth of sugar beet cuttings. *B* — Growth from a beet with a tendency for a sprangled root condition. *C* — Vegetative cutting from the wild beet, *B. maritima*, showing reproduction of the extremely sprangled root condition which characterizes these wild beets. Many queer shapes and forms result from the twisting of roots grown from vegetative cuttings of beets. In some instances plants grown from beet cuttings have weighed over 10 pounds.

naphthaleneacetic acid develop many roots directly from the stem as well as from the cut surface and the roots are not always situated directly beneath the leaves. Beet cuttings without leaves and without hormone treatment do not take root. These facts are interpreted by Went and Thimann[4] to mean that hormones necessary for initiation of roots are produced in the leaves. Evidently beet leaves produce these hormones in considerable abundance in view of the initiation of roots within eleven days without hormone treatment as shown in Figure 6*D*.

Favorable conditions in the cutting beds are, of course, important as well as the choice of healthy and vigorous cuttings. The matter of sterilization to avoid harmful fungi and bacteria, the maintenance of a relatively high humidity and the avoidance of direct sunlight exposure are factors that every horticulturist recognizes. With vigorous, healthy beet material from semi-vegetative seedstalks the writer's experience has been that beet cuttings root more readily than those of the common geranium.

The amount and rate of vegetative growth produced after beet cuttings take root is equal to the growth of beets grown from seed under comparable environmental conditions. The growth from beet cuttings results in a great variety of shapes, partly root tissue and partly stem tissue (Figure 7). Frequently, new vascular rings develop in the stem tissue (Figure 6*E*) and as this tissue increases in size, with vegetative growth, large beets with peculiar shapes may result. Beet cuttings spaced 12 inches apart in 20-inch rows in the field, after roots are developed in a cutting bed, have normally grown to be two or three-pound beets and some have weighed as much as ten pounds. Sometimes, the stem tissue cannot be easily distinguished from root tissue by superficial observation but differs from root tissue in that leaf buds may be easily produced in any position by cutting back the leaves and buds already developed.

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Bureau of Animal Industry Wants Poultry Coordinators

FEDERAL and State officials are cooperating in the administration of the National Poultry Improvement Plan. In connection with this program, the Bureau of poultry coordinators and the Civil Service Commission has just announced an examination to secure persons to fill these positions.

The work involves consultations with State poultry officials concerning poultry improvement and the development of State programs in this regard. Poultry coordinators will advise hatchery men, flock owners, and poultry breeders on their work in conformity with the provisions of the National Poultry Improvement Plan. Their duties may also involve the preparation of articles and the giving of radio talks on this subject.

Applicants for this examination must have completed a 4-year college course with major study in agriculture which included courses in poultry husbandry. In addition, 5 years of experience in administering or supervising organized poultry improvement work are required. This experience must have demonstrated an applicant's ability to organize, direct, and coordinate activities under the National Poultry Improvement Plan.

Applications must be on file with the Commission's Washington Office not later than August 1, 1941. Further information and application forms may be obtained at any first- or second-class post office, or from the Civil Service Commission, Washington, D. C.

FUTURE "IDEAL" GRAPES

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HEALTH and resistance to disease are prime requisites in any plant. With the grape they are most important. This fact stands like a tombstone above the grave of that once enthusiastic effort to build the so-called "Direct Producer" vine. This was to have been the ideal hybrid development which would, according to the dreams of former vinyardists, combine in a single plant the fruit quality of the European grape with the healthiness of the more rugged American kinds.

Quality was attained, to be sure, from some of the first breeding attempts. We need but to taste the delicious berries of such kinds as Agawam, Delaware, Lindley, Goethe, etc., to be convinced of that. But few of them even approximate the variety Concord in practical value, despite their superior fruit quality. Aside from certain needless imperfections of vine, flowers, etc., the cause of this appears to be a step-down in resistance to disease.

In most instances the results of the early "Direct Producer" attempts show an inverse ratio as between fruit quality and vine healthiness. The few hybrid sorts which proved sufficiently disease free (hybrids of *Vitis vulpina; V. rupestris;* etc.) bore small, seedy or sour fruit. These initial difficulties in evolving the visionary "Ideal" grape led to the almost complete abandonment of that worthy and once enthusiastically pursued program.

Previous Results Misleading

From the early disappointments there came into being the now-prevalant dogma which says, in effect, that *vinifera* or European parentage in a hybrid grapevine means just that much weakness and susceptibility to disease. Judging solely from these early experiments we cannot deny such a theory. But we do doubt, and in all sincerity, that the matter could have been given the complete and thorough-going investigation which it deserved. When based upon the results of recent experiments this doubt becomes little short of a conviction.

Recent investigations by the writer, which has involved much unusual and hitherto untried material and many new hybrid combinations, has not only indicated the inaccuracy of the theory that all forms of the European grape impart a susceptibility to disease to their hybrids, but has shown that in rare cases such parentage in the hybrid may even contribute toward the resistance to certain fungus or insect attacks. This point is of great significance and may tend to revive the quest for our elusive Direct Producer kinds.

In the author's test vineyard there are a few new F_1 hybrids, having fifty per cent European "blood" in their make-up, which have shown a degree of disease resistance scarcely surpassed in the entire genus *Vitis*. Such are, of course, rare cases and have resulted only from certain hybrid combinations. The full extent of this disease resistance under all and varying conditions, or of the means through which it is instilled in the progeny by a considerably weaker parent, or parents, is not yet fully understood. It seems hardly probable that such uncommon healthiness can be the result of a simple recessive quality inherited from either parent, or that it is the result of hybrid vigor. A more likely solution would be that it is either the result of mutation or has come about through some peculiar conjugation of genes; wherein two negatives form a positive, so to speak. (Investigations conducted by the writer appear to indicate that the unusual resistance to disease shown in certain of these hybrids, is probably brought about through complementary additions from both parents. In the case of *Plasmopara,* resistance to initial infection appears to come from one parent, and resistance to spread of the mycelium through the tissues from the

other. In the parent forms the absence of either complement often renders the other scarcely noticeable and of little value.) There has been much evidence in support of the latter theory.

In all events the results indicate, in contradiction to the dogma mentioned previously, that both rugged health and a high per cent of *vinifera* parentage can be attained in the same vine.

In view of this latter evidence it would appear interesting to make a reinspection of the earlier experiments which tell such a different story. Let us see why it was that these first attempts to develop the "Ideal" hybrid grape netted so little encouragement. The American species employed in these former breeding experiments were, in order of their importance, something like this: (1) *Vitis labrusca;* (2) *V. rupestris;* (3) *V. vulpina;* (4) *V. aestivalis;* (5) *V. berlandieri.*

In the case of *Vitis labrusca,* which was the species most extensively employed by American breeders in developing American × *vinifera* hybrids, we have learned by observation, both in the vineyard and in the wild, that *labrusca* is one of the least healthy American kinds, particularly so in regard to phylloxera injury. The large size of its berries won it a place of undeserved favor with the early grape breeders, despite the fact that in many respects it is decidedly inferior to several other native American sorts. The last named kinds are more healthy than is *V. labrusca,* though from the standpoint of fruit size they have little to offer.

Still, it seems that the European experimenters who developed hybrids of these more healthy American kinds with the European grape should have received for their labors something in the way of a better Direct Producer. This would appear especially so in view of more recent findings. That they did not, obviously rests upon the fact that such was not the primary aim. In most cases the real goal of these early breeding attempts by French, Italian and German workers was to produce a healthy graft-stock upon which to graft the tender *vinifera* vine. This fact, in addition to the realization that some of the parent material we now find most promising was not then available, offers us an understanding of why the "Ideal" (American × European) hybrids were never evolved.

Selection of Parent Material Important

Perhaps it would be interesting to discuss something of the mechanics necessary in the building of the more rugged Direct Producers of the future. Since we have ample proof that high quality is easily obtainable in the American × European grape hybrid through a careful selection of parents, our one important problem is to produce this superior fruit on relatively healthy and disease-free vines. Before this can be done we must first know just what are the more important weaknesses and maladies, and how they can best be overcome. The most destructive pests toward which our so-called Ideal grapes must show a high resistance are as follows: Root Louse (*Phylloxera vastatrix*); Downy Mildew (*Plasmopara viticola*); Black Rot (*Guignardia bidwellii*); Anthracnose (*Sphaceloma ampelinum*); Ripe Rot (*Glomerella cingulata*); several leaf spot fungi, berry worms, etc. Perhaps there is no American nor European kind which can show complete immunity to all of these troubles. There are, however, several wild American species which register such high resistance as to be practically immune.

When we compare the most healthy forms of several species (*Vitis cinerea, V. vulpina, V. tiliæfolia, V. rufotomentosa, V. champini, V. cordifolia, V. argentifolia, V. æstivalis,* etc.), with the much-used *V. labrusca* in the matter of resistance to Phylloxera and certain fungus diseases, the superiority of most any of the former group is apparent. That fruit size can be readily increased through breeding with large berried *vinifera* kinds has been demonstrated.

In the effort to develop a class of more healthy American × European hybrid

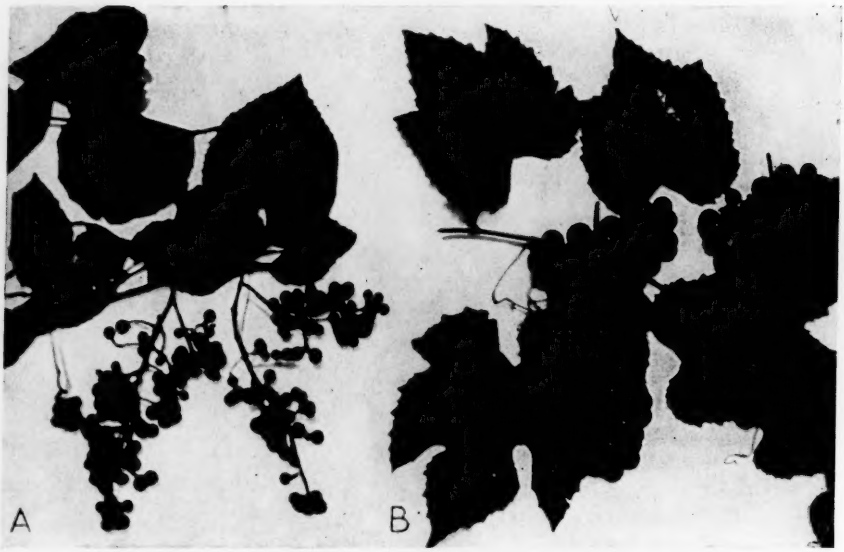
THE FAIRCHILD GRAPE
Figure 8

This novel hybrid shows the improvement possible through using the more healthy small-fruited American species. It is an F_1 hybrid of the Central American "uva cimarrona" (*V. tiliaefolia*, See Figure 9) and the European variety Alphonse Lavallee. Though neither sprayed or dusted it has been vigorous and healthy in a region where grape pests are unusually devastating. It is the first improved grape on record to be derived from a tropical wild species, which was introduced some years ago by the U. S. Department of Agriculture.

grapes it is of course very important to find and employ in the breeding work those vinifera varieties which combine and impart to the progeny the best disease resistant factors. In past efforts it appears that very little attention was given to this important phase of the work. As evidence of this we can cite the frequency with which the variety Black Hamburg was used as a breeding parent. It is probable that more than half of the *vinifera* blood now extant in varying degrees in most of our eastern American cultivated kinds, is of this highly Downy Mildew susceptible variety. Since several of the worst diseases of the grape were not common in Europe at the time of the major Direct Producer hybridizing efforts it is doubtful that even there much attention was given toward selecting against such troubles as Downy Mildew, Black Rot, etc.

Certain Resistant Factors in The Vinifera Type

In connection with the author's efforts at grape amelioration a test has been conducted to determine the most disease resistant and generally suitable varieties of the *vinifera* species. Within the past six years something over thirty varieties of the European grape have been sub-



A SIMPLE ARGUMENT FOR THE "DIRECT PRODUCER" GRAPE

Figure 9

The wild parent (*A*), *V. tiliaefolia,* shows dominance in the hybrid (*B*) in: leaf texture, wood texture and color, disease and insect resistance, season of principal growth, berry pulp surrounding seeds. The *vinifera* pollen parent (not shown) shows varying dominance in: leaf margin, budding date, flower self-sterility, berry size, flavor, bloom, sugar content and outer or "skin pulp"; color size and shade of seeds. Other characters are intermediate, — the hybrid being partially evergreen like its seed parent.

jected to harsh comparative vineyard tests. This group included most of the better known commercial kinds. There have also been available for observation a collection of wild and semi-wild sorts from Persia, Haiti and India. These tests have shown a wide variation in disease resistance among the *vinifera* kinds.

A few sorts, including Feher Szagos, Perle de Csaba, Gros Colman, Cabernet Sauvignon and Malaga have indicated considerable resistance to *Plasmopara* and to certain leaf-spot troubles which badly attack some American varieties. Among those varieties seriously susceptible to *Plasmopara* a difference in the manner of attack was also noted.

Upon kinds most affected by the disease, which included such well known sorts as Sultanina, Black Monukka, Black Hamburg, Flame Tokay, Rose of Peru, etc., the mildew took the form of solid patches of luxuriant growth which spread progressively in all directions until the entire organ was affected. The few points of infection which enlarged vigorously despite frequent applications of Bordeaux (applied after infection) indicated an almost complete lack of resistance to spread of mycelium through the tissues. In this case the only protection against the malady was a slight resistance against first infection.

With certain other susceptible, though less injured, kinds which included Alphonse Lavallee; Red Hanepoot, Muscat of Alexandria, etc., the manner of attack was obviously different. Here there appeared at one and the same time innumerable points of infection, each of which made little or no enlargement in size, though they occurred in such great numbers as to produce much the same effect. Investigation appeared to indicate that in this case resistance was almost wholly a matter of physical or chemical obstruc-

tion to the spread of mycelium through the tissues.

Both types of resistance to *Plasmopara,* or lack of it, as observed in the *vinifera* species have likewise been found in the American wild kinds. There is indication, also, of a probable difference in the optimum conditions for infection as between certain species and varieties. This is probably directly correlated with the size, shape and/or number of the stomata openings and their response to influences of temperature and moisture.

In breeding experiments conducted by the writer these various factors of disease resistance have been combined in many ways. Some crosses have produced very susceptible progeny, and others extremely resistant. Secondary crosses have brought out these resistant factors in interesting recombinations.

Working Plans for The Better Hybrid Sorts

From a methodical evaluation of the various weaknesses to be overcome, as compared to their best relative values of resistance in the extensive breeding material available, we conclude that there is scarcely a problem in our quest for the superior Direct Producer vine which is impossible of solution. By a judicious selection and proportionment of basic parent material, combined with a rigorous campaign of selection for desired qualities in the progeny, we find that, theoretically at least, our better hybrid sorts have conquered all major obstacles. In the mind's eye we see a good sized high quality fruit, approaching *vinifera* in character, borne on vigorous, productive and self-fertile vines which are satisfactorily resistant to most all diseases and insects, including *Phylloxera.* Results so far obtained by the writer have unquestionably indicated that this ideal is well within the range of possibility, even though it has not yet been embodied completely in a single plant.

With a clear understanding of the material, knowledge and results connected with the Direct Producer attempts of former years, as compared to their equivalent today, there is much encouragement. Will the dream of the "Ideal" grape ever dawn into full reality? That question, of course, no one can answer. But there is promise in the conviction that it is yet an open question, and that there is so much which points to the affirmative.

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Biological Symposia

MORE than 160 of the nation's leading scientists and scholars, including thirty-two distinguished men and women who will be awarded honorary degrees, will report basic achievements and advances in learning in a five-day series of symposia sponsored by the University of Chicago. The learned gatherings will be held on the Midway Quadrangles in the week climaxing the celebration of the University's Fiftieth Anniversary, beginning September 22.

Thirty-nine universities, including six in foreign nations, and fifteen museums, research organizations, and government agencies will be represented in the symposia. They will deal with newest fundamental advances in the biological, physical, and social sciences, the humanities, law, business, religion, and social service, in keeping with the theme of the University's celebration, "New Frontiers in Education and Research."

Symposia subjects include: aviation medicine, cancer of the lungs, the problem of overabundant evidence in historical research, cosmic rays, oil geology, social implications of vitamins, transformations in atomic nuclei, and the relations of government, the individual, and large-scale enterprise in the economy of the future.

The following are among the subjects and speakers in the symposia:

"Growth and Differentiation in Plants"—Charles E. Allen, University of Wisconsin; Edmund W. Sinnott, Yale University; John W. Mitchell, U. S. Department of Agriculture; John M. Beal, University of Chicago.

"Visual Mechanisms"—Selig Hecht, Columbia University; Ernst Gellhorn, University of Illinois; Samuel H. Bartley, Washington University; Karl S. Lashley, Harvard University, and Arlington C. Krause, Heinrich Kluver, Theodore J. Case, and Stephen Polyak, University of Chicago (Sept. 24).

WHAT USE CAN THE PHYSICIAN MAKE OF MEDICAL GENETICS?

MORTON D. SCHWEITZER
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DOCTOR Allan's experiences with hereditary diseases in children are the most eloquent testimony of the need for the interpenetration of genetics with medicine. Last summer, I had the pleasure of enjoying his hospitality and the opportunity of seeing some of the living consequences brought about by our social neglect of the field of medical genetics. Less than twenty miles out of Charlotte, perhaps the largest city in the state of North Carolina, we visited the home of a family, where two of the six children were incurably ill with progressive muscular dystrophy. The mother, with touching faith, made only two simple requests—that we do what we could to save her younger children from the same fate, and that she be spared bringing into the world any more children who might share in the suffering of her family, and very possibly add considerably to it. This woman's plea is symbolic of the whole problem and the responsibility for its solution lies with society. For while it is true that medicine is not yet able to *cure* in many cases, society can do a great deal to *mitigate* and *prevent*. And this is not being done.

But I do not want to dwell this morning on the sadness of unnecessary human suffering. Rather let us turn to the broader aspects of our subject, which are of deep concern to all of us here. I would like to speak of some of the ways in which genetic concepts have been forcing their way into medical thought and research and even, to some extent, into the daily life of the practicing physician.

It appears somewhat strange that medicine should have been so slow to incorporate into its thinking the fundamental conclusions of genetics. This is in marked contrast to the history of bacteriology, for example, which almost from its beginning was accepted into the pattern of medical research, and soon changed it completely. This lag in the acceptance of genetics is not due to the paucity of its accomplishments, for we know that the application of genetic principles has transformed our agricultural economy. Plants and animals today are bred not only for increased yield, but also for disease resistance, tolerance to drought or excessive rainfall, adaptability and for other traits of importance to the farmer and processor, or even to the taste and predilections of the consumer. In the face of these achievements, it is particularly pertinent to inquire why the role of heredity in disease has been discounted by medical scientists. Undoubtedly many reasons can be found but it seems to me that the most important one is that the fundamental notion of heredity and its relation to environment has been terribly confused. People have been, and to a great extent still are, either "hereditarians" or "environmentalists," and the debate is still raging as to which is more important.

While this problem has been the subject of major controversies in psychology and the social sciences, medicine has also been involved at various times. Until the first decade of the present century, the designation "hereditary" was rather indiscriminately applied to a variety of diseases and conditions for which no other etiology was known and which were generally incurable. More recently, we witnessed the trend toward the minimizing of the factor of heredity, largely as a result of the discovery of the etiological factors in tuberculosis, pellagra and other diseases formerly regarded as hereditary.

One important reason why the controversy has persisted down to the present is that the methods of investigating each factor are so different, that it has not seemed possible to reconcile the results of both types of studies. In physiology and experimental medicine, it is customary to introduce changes in the environment under circumstances which make it possible to ignore the factor of heredity in evaluating the results of

studies. (While this condition is not always realized in practice, it is, albeit, tacitly assumed.) In experimental genetics, on the other hand, it is the usual practice to observe the interplay of genetic factors when environment forces are maintained constant.

As a result of both types of studies and their application to medical problems, it is possible to compile a formidable list of diseases and conditions, such as epidemic influenza and measles, which may become manifest in genetically diverse individuals, and which are not, by present standards, subject to any genetic control. And it is also possible to describe a considerable number of genetically determined traits, such as partial color blindness and hemophilia, which are only slightly, if at all, amenable to environmental influence.

Interdependent Factors

While these differences are significant, they are not interpreted today as representing a sharp dichotomy between heredity and environment in the determination of all human traits and affairs, as was formerly believed. There is a rich variety of evidence that the mutual interaction of nature *and* nurture, determines the structures and behavior patterns of all living things. While one is the antithesis of the other, neither *does* or *could* exist alone. If all human aberrations were arranged in a series with respect to the relative influence of heredity and environment in their causation, measles and hemophilia would appear as the extremes of a continuum in which all degrees of importance of both elements were represented.

When hereditary factors are shown to be important in the determination of any human trait, it is often tempting to suggest that the environment may be ignored (and vice versa). The shortsightedness of this view is apparent when we consider that methods are now available for investigating the point, so that an *à priori* judgment is as unnecessary as it is dangerous. Certainly, it cannot be precluded that further study may bring to light realizable conditions which may negate the implications of the preceding analysis. (The same criticism may be made of the reverse argument regarding the preeminence of environment in given diseases.)

It is evident that the "balance," so-called, between heredity and environment for a given trait is not necessarily immutable but may be subject to modification with changing conditions of life, and as medical and public health procedures vary. For example, endemic goiter in the Great Lakes region may formerly have occurred because of constitutional, that is, hereditary differences in susceptibility to iodine deficiency; but since the introduction of iodine therapy, the occurrence may be more properly attributed to the environmental deficiency of iodine. The same argument may be made with regard to smallpox. During periods of universal exposure, such as occurred during the pandemics of the Sixteenth Century, those who escaped the disease very possibly did so because of an inborn resistance. At the present time, this disease occurs only in (exposed) individuals who have not recently been vaccinated. In both diseases, heredity has been shifted from a major factor to a (potentially) minor role, with increasing knowledge. The opposite trend might equally occur; that is, a disease due "principally" to environment might under other circumstances become principally subject to hereditary effects. If an effective vaccine for human glanders (at present invariably fatal) or epidemic influenza were to be perfected, then the only individuals who might remain subject to these diseases would be those constitutionally unable to store, or tolerate, the protective element. Sometimes an improvement in diagnostic criteria is *enough* to shift the balance.

This change in relative importance of heredity and environment cannot, however, be compared to the simple swinging of a pendulum. For every time the balance is shifted, the entire scope of the problem may be radically altered. For instance, tuberculosis and rickets loom much larger on the medical horizon today than seemed possible little more than

a century ago. On the other hand, the public health problem of epidemic influenza would become much smaller than it is if a vaccine were developed. For then only individuals constitutionally resistant to the vaccine could acquire the disease.

We are thus brought to the conclusion that in medicine, as elsewhere, the point at issue is not heredity *or* environment, but rather how much of each. The relative importance of genetic and extrinsic variables in the particular disease is a matter for investigation rather than *à priori* argument; and the ratio is subject to change or reversal, with increasing knowledge or with changing conditions. However, at any given time, *that* variable will appear most important which offers the greatest impediment to the control of the given condition.

This harmonious interrelationship between medicine and genetics is only beginning. Up until now, the physician has been content to ignore genetical problems and the geneticist has been aloof from the main currents of medical thought. Consequently, more often than not, studies in medical genetics suffered from inadequate recognition of clinical considerations. In addition, they were usually based on small numbers and were not controlled for the environment factors which might have contributed to the results.

A New Role for the Geneticist

As a result of our newer concept of human heredity, the role of the geneticist in medical research is undergoing a profound change. Formerly, he was cast in the role of the mythical Cassandra—an unhappy bystander uttering warnings which were as unwelcome as they were gloomy. Today, he must assume part of the responsibility and share in the consequences, wherever they may lead. This change is most marked in the field of infectious diseases, formerly the inner sanctum of the environmentalists.

While much has been learned about the causation of these diseases, the spotlight has been focused on the invader, with relatively little attention devoted to the equally indispensable host. But there has been a gradual shift in emphasis. At first, the host was considered of little importance except insofar as a knowledge of pathology might facilitate recognition of the specific etiological agent. Later, when it became apparent that the host could not be ignored, inquiries were and still are made of conditions and circumstances which might facilitate the entry of foreign organisms. But even this has proved inadequate, and recently more penetrating questions have arisen. To cite a few representative ones that are engaging the attention of medical investigators today: Why will one patient, invaded by poliomyelitis virus, exhibit the classical manifestations of infantile paralysis, while his brothers and sisters, equally invaded, may show no more serious symptoms than we find in the common cold? What differences between individuals will account for the distribution of rheumatic fever between and within families? Why will some individuals, exposed to a type-specific strain of pneumococcus, harbor the organism while others, equally exposed, will not; and why do only a small minority of the carriers come down with pneumonia during any season?

Unfortunately, we cannot answer all these questions, even tentatively, but in some diseases substantial beginnings have been made. I would like to illustrate these new developments in the case of rheumatic fever, which disease I have been studying with Dr. May Wilson in her clinic at the New York Hospital. This disease is among the major causes of death in childhood and adolescence. While even a single episode may cause serious heart damage, the course is usually chronic and each attack progressively weakens the heart. Its incidence and severe sequelae occur disproportionally among the underprivileged, thus emphasizing its public health importance. While the factor of heredity in rheumatic fever was suggested at least half a century ago, it was largely ignored in the older medical and epidemiological studies, whose results were equivocal. Within the past five years, however, adequate data have become available, which

make it possible to study on a par with the other features of the family epidemiology. Our analyses suggest that there is a constitutional factor for susceptibility inherited in simple recessive fashion, that is, from both parents. While additional evidence for the specific genetic mechanism is needed, our general interpretation has recently been supported by other investigators. These results explain the failure of many of the previous studies, which must have included mixed populations of susceptible and immune individuals in unknown proportions.

Formerly, the study would have stopped at that point, for investigators were satisfied with a general statement of relationships. Once the geneticist had proved the role of heredity, he considered that his job was done. But, in fact, it was not. On the contrary, a whole host of new problems has been opened up—What other factors are necessary to produce the disease? Is there a specific chain of events which precipitates a first or later attack of rheumatic fever? Does heredity play a part in all aspects of the disease or in a few? Is it communicable in any degree? What is the effect of the environment? . . . . These are a sampling of the questions that remain. And the answers must be found not in vague generalizations but in the specific and quantitative language of family epidemiology.

In turning from the *causes* of diseases to their *treatment*, the need for the study of constitutional differences is equally apparent. It is a striking fact that the new sulphonamide drugs, whose great effectiveness is well known, can *not* be tolerated by many people. This can hardly be due to previous sensitization, since most of the drugs are so new. The suggestion of a possible hereditary basis for the sensitivity appears quite consistent with everything we know, and would repay further study. I will venture this speculation—that the administration of chemotherapy of various types may in the future be conceivably conditioned by a species of preliminary testing, comparable to that which now precedes an ordinary blood transfusion.

New Outlooks

In the past, the study of hereditary diseases has been a little-travelled bypath of medical science, restricted by the narrow confines of the older dichotomy. That is to say, heredity was regarded as a fixed element, whose effects could hardly be altered even by the most extreme changes in the environment. Consequently, all hereditary diseases were predetermined in their origin and predestined as to their end. Almost all that could be achieved in this field, therefore, was the elucidation of the specific mechanism of Mendelian tranmission. While this knowledge might have helped in preventing the appearance of these diseases in future generations, little hope was offered for those currently afflicted. Accordingly, an opportunity for real service being thus denied, an attitude of indifference and even of scorn developed within the ranks of the medical profession. This may well have been the origin of the stigma attached to hereditary diseases, which sentiment, in fact, pervaded not only the medical literature but, ironically enough, the genetic literature as well. But these ideas have since been consigned to limbo, together with our mid-Victorian prejudices concerning venereal diseases. Today no thoughtful person would condemn a child afflicted with progressive muscular dystrophy any more than he would another with a constitutional idiosyncrasy to sulphanilamide. With this healthy changed attitude, medicine is correcting a manifest injustice which has caused untold fear and suffering, and is, at the same time, paving the way for the future development of effective treatment of these hitherto neglected conditions.

"Art" Aspects

If the illustrations I have given are but sectors of medicinal science, they are those portions in which the acceptance of genetic concepts would appear to promise the greatest immediate returns in terms of a constructive research program. It must be remembered that in its present position of relative isolation, Medical Genetics itself is as yet imper-

fectly developed. Many clear-cut "hereditary" diseases have been inadequately studied in their decisive genetic aspects. Also in an embryonic stage are many theoretical and social aspects necessary for the development of a concrete program of eugenic control. All this makes any present discussion of a practical eugenic program extremely hazardous. Nevertheless, any presentation of Medical Genetics in relation to Medicine must deal, however, incompletely, with the problems that may confront the physician.

In the solution of these problems, the medical practitioner has a dual role, for Medicine is truly both an art and a science. Thus far, we have been concerned only with the science.

Its art is practised by the family physician, who, on his daily rounds, brings to his patients the best knowledge of the day and tries to fit it into the pattern of the varying personal and family situations that confront him.

How does Medical Genetics fit into this picture? In two general ways, we might say, paralleling the doctor's dual role. Not only is he called upon to cure all the ills, big and small, that beset the human race, but he is often called upon for help in solving the most intimate and personal problems. In his strictly medical capacity, knowledge of the hereditary pattern of a given disease will assist him in differential diagnosis and early recognition of minimal symptoms. But inasmuch as this particular subject has recently been discussed in the medical literature, I need not take time here to dwell on it.

As the family counsellor, the physician is often asked for advice on marriage and raising a family. Here, an accurate knowledge of the genetic situation may often be indispensable. In the past, not having the genetic knowledge, doctors were often in disagreement as to the consideration to be accorded genetic factors in marriage and child-bearing.

It has been argued that, inasmuch as the environment of man is amenable to control, it is unnecessary as well as potentially dangerous to emphasize hereditary weaknesses. However, our public health responsibility cannot thus easily be discharged, for a civilized community must recognize the right of parents to have healthy children. Surely, a physician would be remiss in his duty if he did not warn the parents of a child with Tay-Sachs' disease, of the danger in having additional offspring.

On the other hand, our present knowledge of Medical Genetics does not justify many of the older claims made by overzealous eugenists. The enforcement of *their* viewpoint has likewise been the cause of a great deal of unnecessary unhappiness.

We have then these two conflicting viewpoints, neither of which is wholly correct, although each has a grain of the truth. Where shall the balance be drawn? The answer to this question defines the art of medicine, and it is not for me to instruct the physician in his art. I only want to suggest that an important ingredient in his training must be some knowledge of medical genetics, so that his advice may be cogent as well as sympathetic.

The pattern of medical practise has been shifting in recent years, so that the responsibility in these matters is now divided between the private practitioners and the public health authorities. The pattern of life itself is shifting *so rapidly* that the conditions of even the next generation appear unpredictable. In fusing with Medicine, Human Genetics will develop its own potentialities, while contributing to the solution of the theoretical and practical problems of modern Medicine. This presents a challenge to both professions—how will this challenge be met?

EUGENICS AND NATIONAL DEFENSE

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EUGENICS has two contributions to make to national defense: to reduce the number of defective persons the country has to support, and to increase the proportion of people born who are capable of being leaders.

If I had never heard of eugenics before, I would have become interested as a result of my six months' work with the Advisory Committee on Selective Service. About five per cent of all men eligible for military service in the United States are not mentally or emotionally strong enough to stand even peacetime military service. Some two per cent of these are being rejected by local draft boards. If there was a more understanding public and medical opinion, another one and one-half per cent could be eliminated before they get into the Army. In Maryland thirty such men were deferred in the first calls as a result of the early cooperation of the Social Welfare agencies with the local draft boards.

Already a proportion of such men who are in the service are breaking down and being sent to mental hospitals. The proportion of emotionally unstable men who got into the service during the last war was three per cent. And the cost to the government of those who broke down mentally in the last war has been $30,000 apiece, to date. Thus the elimination of 30 men in the Maryland contingent saved the taxpayers nearly a million dollars.

The total savings to be made by keeping all defectives out of the new Army would be fantastic. Officers who have been in charge of troops in the field know well what it would mean to the morale of the troops to keep the emotionally unstable out of the Army in the same way that other more obvious defectives are kept out.

Two or three million people in the United States are so seriously defective in mind or body that they are a tragic burden to themselves, to their families and to the communities in which they live. A majority of their defects have a constitution, that is, a hereditary basis. The cost of their care alone is probably a billion dollars a year. They handicap our national life and handicap our preparations for defense.

Our American doctors and our great Public Health Service can reduce the incidence of persons born with a tendency to defect, just as surely as they have reduced the incidence of infectious diseases such as tuberculosis and yellow fever. And they can do it by conservative methods quite generally approved by the public—registration, segregation and refusal of marriage license to the feebleminded; use of contraceptives under medical advice by mentally normal carriers of defect; extensive search for bad family strains.

But health authorities can move only as fast as public opinion permits. The intelligent public should not be confused by unnecessary controversies and exaggerated statements. The public should insist that doctors and public health authorities get to work at reducing the number of defectives. As Justice Holmes said, "Three generations of feebleminded are enough." In the name of common sense, common decency and national defense, let us begin this job with the knowledge and the methods now at hand. An intelligent attack could reduce the incidence of defect ten per cent a year for several years.

This should be the first contribution of eugenics for national defense. Its second contribution is even more important.

Leaders Needed

Democracy can survive only if it finds leaders for all its many needs. Leader-

ship does not come from training *alone,* but from the training of *able persons.*

For instance, though there are many able men in the Army, many more could be used to fill the posts demanding a high quality of leadership. At present about a hundred men are needed for the morale branch. Part of this number has been found, and a pool of reserve officers remains to be tapped. But, because of the difficulty of finding additional men of the right quality who can be spared from the training of troops, the setting up of the morale branch is necessarily a slow business.

Able human stocks are to be found among all the different social groups, the different racial groups, the different geographic groups in the United States. No social class, rich or poor, Fifth Avenue club or Alabama labor union, has any monopoly of either virtue or vice. There are able family strains and weak strains everywhere.

The considerable research that has been done on socio-economic and class differences has proved practically nothing with respect to heredity as between rich and poor, colored and white, etc. Those who tell you that eugenics has to do with race or class differences are giving voice to an emotional bias rather than an opinion based on scientific research.

There is no controversy about the relative values of heredity and environment. They are interdependent and interrelated.

In general, children tend to be like their own relatives. We must create a society in which, at every economic level, parents who are responsible and competent will have more children than their irresponsible neighbors. That is not the sort of society we have today.

Social conditions are not such that the most competent have the largest families. We must work to remove some of the handicaps attached to having children.

The right to have or not to have children must be safeguarded in a democracy, along with the right to freedom of speech and freedom of worship. No man has the knowledge, or should be trusted with the power, to decide who should or should not have children. Arbitrary control of births as in a dictatorship is not eugenics; it may be only a distorted use of science for evil ends.

Democracy is the necessary safeguard of eugenics. At the same time, only an able people can maintain a democracy. Ability is not solely a matter of training or cultural tradition; it must be constantly renewed from one generation to another by the children born of able strains.

Without social conditions in which the abler stocks from every class and section of the country have good-sized families as a natural, largely unconscious process, democracy will inevitably fail over a period of time for lack of leadership.

In this period of national emergency, we are closer than before to the fundamentals necessary to our survival; among these fundamentals is the creation of eugenic conditions of society, such that our people will retain those native qualities which will perpetuate the highest ideals of democracy and a high civilization.

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"Starved" Chromosomes Suffer Typographical "Crossover"—A Correction

In the April, 1941, issue of the JOURNAL the legends to Figure 3 and Figure 6 became transposed, an error which the editor whole-heartedly regrets. Figure 3 is an anaphase in a root-tip of *F. Pudica;* Figure 6 is the pachytene stage in an embryo-sac mother-cell. This shows the prominent nucleolus, sadly lacking in the illustration in which it is alleged to appear as the article was published.

SUPERIOR INTELLECTUAL ABILITY

Its Selection, Education and Implications

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SUPERIOR intellectual ability is a collocation of words—words that express a relationship and that imply a definition. The implied definition will depend upon the viewpoint of the interpreter of intelligence tests or upon the viewpoint of the maker of intelligence tests. At the present time, there are at least four different ways of looking upon intellectual ability,—the biological, the statistical, the education and the empirical. There have been many other points of view expressed, but four will be sufficient to indicate confusion. The biological description of intellectual ability considers the ability as a capacity of conscious adjustment to the problems and situations of life; the statistical description is an analysis of performances of individuals into a factor or factors accounting for the relationships among test scores; the educational definition is in terms of the individual's ability to learn; while the empiricist considers intellectual ability as good behavior, or good responses to situations from the point of view of truth or fact.

The confusion at the present time is among concepts of intelligence that consider intelligence as biological capacity, that consider intelligence as learning, and that consider intelligence as good behavior. But intelligence can be any one, or any combination of these and other factors. Intelligence is an operational concept deriving its genuine definition from the steps taken to appraise it. Intelligence can never be measured directly. It can only be inferred from indirect observations of the performances hypothesized to be intellectual in origin. To elicit performances that can be appraised as intellectual, a standard and standardized series of tasks and problems is presented to an individual for his performance. The assumption is made, that all other things being equal, persons within the same environment will perform differently depending upon the amount of the so-called "intellect" they have. Operationally, intelligence is a function of the number of successful performances on the standard series.

It is important to keep this operational definition in mind. If intelligence is defined as the number of successful performances on a standard series, it can be seen that the operation implies an environment. As a matter of fact, the tasks and problems are environmental; the success on these tasks is defined in terms of goodness of response in a specific culture, and on a particular level or set of levels in that culture. Tests of intelligence measure a person's ability to deal with aspects of his environment in terms of values in his environment at the time and up to the time of testing.

Intellectual ability, that is, intelligence as measured by intelligence tests, therefore is operationally environmental, and only inferentially biological. If a measure of intelligence is obtained for an individual, who was in good rapport with the examiner, who had opportunity to benefit from his environment and whose environment was within the scope of the standardization of the instrument, the score or measurement or quotient may be considered a valid estimate of the quantity or quality of "intellect" possessed. If rapport, experiences, or environment deviated from such specified conditions, the score would tend to be either an underestimate or an overestimate of his "intellect."

Many Measures

The fundamental assumption in the measurement of intellect is that operations used to appraise it, are like the operations used in defining the measuring instrument. But there are many measuring instruments for estimating the amount of a person's intelligence. These various instruments differ among themselves not only in their operations, but also in their interrelations. Tests of

intelligence vary in their sampling of tasks, in the presentation of such tasks, in interpretations of success and so on. Let us consider two such tests in intelligence given to 340 children within one week. One test was the Merrill-Palmer, the other the Stanford Revision of the Binet. The differences in average I.Q. was about 5 points for the total group. If the children are classified according to the Merrill-Palmer I.Q.s and the average I.Q. on the Binet is computed, the material becomes quite diverting. For instance, 66 children in the I.Q. range 100 to 110 on the Merrill-Palmer average 104 on the Merrill-Palmer and 118 on the Binet—a positive increase of 14 points. Or again, children with an average Merrill-Palmer I.Q. of 153 have an average Binet of 138, a loss of some 15 I.Q. points.

Conversely, children with an average Binet I.Q. of 154 have an average Merrill-Palmer I.Q. of 135, a loss of some 19 I.Q. points. The tests cannot be considered equivalent either in the scores each yields, or in the performances each elicits, or in the kinds of inference each allows.

In the hands of a trained examiner, an intelligence score can be used to yield fairly good estimates of current and potential mental ability. If the trained examiner uses a well standardized, well validated and reliable test, and if the child comes from an environment included in the scope of standardization, the score will be representative of the child's ability. Within a fairly homogeneous environment, with tests which are a sampling of tasks such an environment affords, differences in test scores are interpreted as differences in native intellect. And in the age range six to fifteen, on the basis of scores from a test like the Stanford Revision of the Binet-Simon, there is a tendency for the same person to obtain approximately the same I.Q. rating on successive administrations of the same tests.

Genes and I.Q.

This tendency for repeated I.Q.s to be approximately equivalent brings us to the expressed relationship in the term "superior intellectual ability." The differences in measured I.Q. among individuals has been interpreted as evidence for some basic differences among individuals in genetic make-up or constitution.

The differences in I.Q. have been interpreted as differences in the kind or quality of the genes of the individual. Those genes have not yet been identified or located. Little or nothing is known about their distribution, or about their mode of inheritance. Suffice it to say, the genes for intellectual ability are not simple characters as is color blindness, or the ability to taste phenyl thiocarbamide. The genes making the intellectual ability may be like the major pair of autosomal genes influencing the pitch of the human voice. Dr. Strandskov reports that in males possessing two similar genes *V bs V bs,* the pitch will be bass, in males possessing a pair of dissimilar genes, *V bs V ta,* the pitch will be baritone, or if the genes are similar *V ta V ta* the pitch will be tenor. In females the corresponding pitches will be soprano, mezzosoprano, and alto, respectively. Probably, many pairs of genes account for the fairly well established normal curve of the distribution of intelligence scores, or I.Q.s.

If voice, size, height, weight, skin-pigmentation, and amounts of glandular secretions depend upon multi-factorial Mendelian traits, it can be postulated that intellect is also multi-factorial. The effect of the combinations of groups of genes then may be considered as approximated in the scores derived from intelligence tests, remembering the operational restrictions implied in such measurements. It is my belief that intelligence basically is genetically determined by, and dependent upon, many pairs of Mendelian factors. It is my belief, also, that intelligence in terms of performance on tasks set in intelligence tests, and on tasks and problems set in life will be somewhat conditioned by the environment and the stage of development. An individual's performances are, in my opinion, determined by the tendencies in his genetic constitution, and by the experiences, activities and needs, he, because of his genetic make-up, seeks, util-

izes, and satisfies. An individual's performance is a function of his genes, and what those genes cause him to do.

Intellectual ability may then be scaled for all living matter from the amoeba to homo sapiens. On such a scale, the range occupied by man will be restricted to the high end of the scale. That high end of the scale may be magnified for man to appear very wide. On such a magnified scale human individuals will be scaled from relatively low through average to very high. With reference to his own kind, the place of a human can be expressed as a deviation from the average. Some arbitrary deviations may be considered as sufficiently different as to be considered indicative of superior intellectual ability. Terman has classified as superior, the individuals whose positive deviation is 20 or more I.Q. points. By Terman's definition, about 5% of the child population with I.Q.s of 120 or higher would be classified as of superior intelligence or better. In the population, about 5% would have an I.Q. of 122 or higher, 3% an I.Q. of 125 or higher; 2% an I.Q. of 128 or higher; 1% an I.Q. of 130 or higher; and ½ of 1% an I.Q. of 140 or higher.

Such an I.Q. can be determined with a fair amount of reliability with the Stanford Revision of the Binet-Simon at age six or later up to age fifteen. After age fourteen or fifteen, other tests may have to be used, such as the I.E.R. Intelligence Scale CAVD. The upper 1, 2, 3 or 5% of intellectual deviates can be selected on the basis of good intelligence tests. Such a selection can be checked by re-examination if necessary. If a person remains in the upper 1, 2, 3 or 5% on two examinations only rarely will he fall out of the classification on third or later tests. The selection of superior ability can be made through the use of good intelligence tests in the hands of good mental examiners.

Little Plus-I.Q., What Now?

After these individuals are selected, then what? It has been suggested that the genetic constitution will cause them to select, utilize and satisfy respectively activities, experiences, and wants. That is true. But even intellectual abilities must be given an environment rich in the opportunities for selection, utilization and satisfaction. Failure to provide such an environment will be as handicapping to the intellectual deviate as visual defect, or auditory defect is to the physical deviate. Superior intellectual abilities can be retarded or limited, or even harmed by an inadequate, unstimulating, or deficient environment. Even genetically superior seeds need cultivation.

Superior intellectual ability is a composite of abilities involving abilities with ideas, things and men. These superiorities are important for the individual that possesses them, and for society that needs them. Society must be foresighted enough, then, to develop them so that the abilities become available to the society. Genius will not always come to the top. Superiority needs nurture to maximize nature. It is unwise for society to spend more on the mentally deficient, and the mentally unable, than it does upon the positive intellectual deviate. It is no less humane to provide an adequate education for the superior intellectual deviate, than it is to provide an adequate education for the physically or mentally handicapped.

The education of the superior intellectual deviate should emphasize experiences and activities that affectively challenge his ability, that provide opportunity for demonstrating initiative, and originality, that will give a range of activities for the learning and development of interests, and that gives the basis for socially significant value judgments. It should be rich, stimulating, dramatic. How best to provide such experiences and activities is largely a matter of opinion. It seems to me, however, that such experiences must be given as the natural right of intellectual superiority.

The education of the superior should begin as soon as the individual is identified. It is a hope that the positive intellectual deviate will be identified somewhere between his sixth and ninth birthday. For all those identified I would propose a special curriculum, under the guidance of specially trained and intellectually superior teachers, housed preferably in a specially designed building,

and administered as a specialized school. Such a proposal suggests segregation, or partial segregation for intellectual activities. I have given much thought to the relative advantages and disadvantages of segregation. Though there are disadvantages to segregation, the desirable outcomes outweigh them. Segregation need not remove the superior individual from his social group, and good teaching and guidance can prevent him from becoming a snob.

The education of the superior intellectual deviate should begin in the primary grade, and be continuous to college entrance. The education in terms of number of years should not be less than that given to less able members of the population. The education should not be forced, or hot-housed, but should be in terms of the ability and maturity of the individuals. The curriculum may be set in terms of the usual objectives of education; it may be either a subject-matter curriculum, or a project curriculum, or an activity curriculum. The important consideration is not what kind of curriculum, but rather what kind of teacher. If the teacher is specially trained and intellectually superior, she can provide enrichment within the scope of the curriculum, be it what it may, if unhampered by petty administrative restrictions.

Among the objectives of the curriculum for the intellectually superior must be a recognition that superior achievement is a fortunate resultant of the interaction of heredity in terms of endowment, maturation in terms of development, and environment in terms of opportunity. Such interactions imply for the fortunate deviate privileges, opportunities and obligations for life in a democracy. The superior deviate must learn to recognize his obligation to capitalize his endowment for the good of his community, just as society must capitalize his environment to that end.

Superior children must be given the opportunity to learn the fundamental skills, with necessary attention to habits of study, industry and thoroughness. They must be given a wide range of experiences in art and music, with machines and things, with people and groups, as well as with ideas, symbols and relationships.

If such a segregated and enriching experience were given, what would be the implications for society? First, a caution. Do not expect every superior intellect to become a leader of men or over things, or with ideas. Superior intellectual ability is but one of the essential components of leadership. Other essentials involve personality, attitude, and drive. In general, those desirable traits will be correlated, but not perfectly. Society can only hope for, and expect, a greater proportion of intellectually superior individuals to become leaders than it can expect from any other segment of intellects. Second, a need. Too frequently, government and industry selects its potential leaders by luck, by pressure, and by good looks. If society wishes effective leadership, it must learn to select its abler members, reward them for the services they perform, and encourage them to strive to serve. This need implies that society must learn to utilize its superior human resources better than it has. Society should not defer the utilization of its superior resources too long. And last, a suggestion. Superior intellectual ability, educated and trained, has some special combination of needed and useful abilities. Society must learn to use these special combinations where they are needed, and learn not to waste the rarer abilities in work that other, or less able, individuals can do as well.

Superior intellectual ability is not a miracle. It is as natural as superiority in height or weight. Basically it is geneticallly constituted. The performance of the superior intellectual deviate will be, in part, conditioned by his environment and his education. Considering the relative rarity of intellectual deviates, society must learn to educate them well, and then learn to utilize them well. It is unwise to educate the superior intellect merely as a demonstration. There must be planning for utilization of one of democracy's basic resources—superior intelligence.

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